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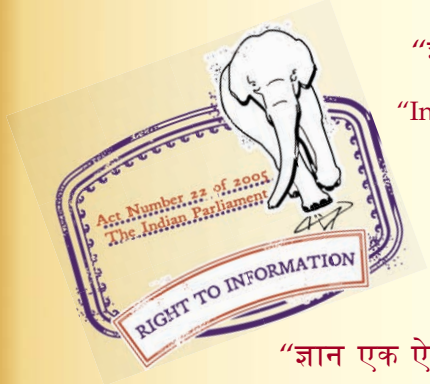

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Indian Standard

SPECIFICATION FOR WROUGHT ALUMINIUM AND ALUMINIUM ALLOY FORGING STOCK AND FORGINGS (FOR GENERAL ENGINEERING PURPOSES)

(Second Revision)

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Indian Standard

SPECIFICATION FOR WROUGHT ALUMINIUM AND ALUMINIUM ALLOY FORGING STOCK AND FORGINGS (FOR GENERAL ENGINEERING PURPOSES)

(Second Revision)

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(*Continued on page* 16)

Indian Standard

SPECIFICATION FOR WROUGHT ALUMINIUM AND ALUMINIUM ALLOY FORGING STOCK AND FORGINGS (FOR GENERAL ENGINEERING PURPOSES)

(Second Revision)

0. FOREWORD

0.1 This Indian Standard (Second Revision) was adopted by the Indian Standards Institution on 26 September 1975, after the draft finalized by the Light Metals and Their Alloys Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first issued in 1956 and subsequently revised in 1966. Further revision became necessary as a number of new alloys which have found wide application in engineering industries were required to be included. Tables on requirements for mechanical properties were reviewed and modified wherever necessary. The main modifications which have been made in this revision are as follows:

a) New alloys 74530, 64423, 65032 (H20) and 24534 (H14) have been included.

b) Aluminium of 99·8 percent purity (FIA), nonheat-treatable alloys 55000 (NF6) and 57000 (NF7) and heat-treatable alloys 22450 (HF11) and 22845 (HF12) which have a limited use have been excluded.

c) Code designations given in IS : 6051-1970* have been adopted in this standard, the old designations being included in brackets for ready reference.

d) Metric units of Systemé International d'Unites (SI) have been used. These have been adopted by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). It is expected that they will become the generally accepted metric units throughout the world. However, during the transition period, equivalent figures in kgf/mm^2 have also been given along with the SI units to facilitate smooth change-over.

0.3 Some characteristics and typical uses of the alloys specified in the standard have been listed in Appendix A.

*Code for designation of aluminium and its alloys.

0.4 The major alloying elements have been printed in bold face in the chemical composition (*see* Table 1).

0.5 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from BS 1472 : 1972 ' Wrought aluminium and aluminium alloys, forging stock and forgings ' issued by the British Standards Institution.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers requirements for forging stock and forgings of aluminium and aluminium alloys in various conditions for general engineering purposes.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Forging — A shape produced by hammering or pressing usually when hot.

2.2 Forging Stock — Cast, extruded or rolled material for the production of forgings.

2.3 Cast — A solid casting of circular or polygonal cross section used for subsequent casting. It may be:

a) the product of one furnace melt or one crucible melt,

b) the product of a number of either crucible melts or furnace melts mixed prior to casting, and

c) the amount of metal tapped from the furnace without any further addition of metal having been made when a continuous melting process is used.

2.4 Heat Treatment Batch — A quantity of material of one alloy, of nearly same dimensions and produced in the same way, solution-treated in one furnace load, or such material so solution-treated and subsequently precipitation-treated in one furnace load. More than one heat treatment batch may comprise a furnace load.

*Rules for rounding off numerical values (*revised*).

3. SUPPLY OF MATERIAL

3.1 General requirements for supply of aluminium and aluminium alloy products shall conform to IS : 1387-1967*.

4. FREEDOM FROM DEFECTS

4.1 Forging Stock — Forging stock shall be free from pipe, undue segregation and surface defects, such as laps, seams and sub-surface unsoundness which might have detrimental effects in the forgings to be manufactured therefrom.

4.1.1 Extruded or rolled forging stock, any portion of which after being heat-treated in the unforged condition, does not give at least the minimum specified mechanical properties, shall be deemed not to comply with the standard.

4.2 Forgings — The forgings shall be sound and free from harmful defects. They shall be made to the dimensions specified on the order or drawing and where the drawing shows that machining is required, they shall be capable of being machined to the finished dimensions without leaving any evidence of the forged surface.

5. CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES

5.1 The chemical composition and mechanical properties shall comply with the requirements of Tables 1 and 2 respectively.

5.1.1 The chemical analysis of the material shall be carried out in accordance with IS : 504-1963† or by spectrochemical method.

5.1.2 The mechanical test shall be carried out as specified in **9**.

6. CONDITION

6.1 The material shall be supplied in the condition as specified by the purchaser. The condition shall be designated in accordance with IS : 5052-1969‡.

7. TOLERANCE

7.1 Tolerance on forging stock shall be as agreed to between the supplier and the purchaser.

8. SELECTION OF TEST SAMPLES

8.1 Forging Stock

8.1.1 For wrought material, one test sample shall be provided in respect of each batch of material of the same dimensions and produced in the same way. The test sample shall be marked for identification with the material it represents before being cut from the bar selected.

*General requirements for the supply of metallurgical materials (*first revision*).
†Methods of chemical analysis of aluminium and its alloys (*revised*).
‡Temper designations of aluminium and its alloys.

8.1.2 For cast material, the provision of test samples shall be as agreed to between the supplier and the purchaser.

8.2 Forgings

8.2.1 *Selection and Quantity of Test Samples* — Forgings which require the same heat treatment, if any, and which are of approximately similar thickness, shall be grouped into lots as follows and, unless agreed otherwise between the supplier and the purchaser, at least one test sample shall represent each lot of forgings or heat treatment batch, whichever is less for mechanical testing:

Weight of One Forging		*Quantity*	*Maximum Weight of Lot*
Over	Up to and Including		
kg	kg		kg
—	0·12	3 000	300
0·12	0·25	2 000	400
0·25	0·5	1 000	500
0·5	1·5	750	750
1·5	3·0	500	1 000
3·0	6·0	300	1 000
6·0	10·0	150	1 000
10·0	—	To be agreed between the supplier and the purchaser	

8.2.2 For forgings in heat-treatable alloys which are supplied in the M or O conditions and which are to be heat-treated by the purchaser, test samples or additional forgings, marked to identify them with the forgings they represent, shall be despatched with those forgings to the purchaser who shall be advised of the method of preparation, number and identification marks.

8.2.2.1 If required by the purchaser, the supplier shall also provide particulars of the recommended heat treatment necessary to produce the required mechanical properties in the forgings.

NOTE — The supplier of the forgings shall not be responsible for the results of heat treatment carried out at works other than his own.

8.3 Preparation of Test Samples for Forging Stock — Test samples obtained in accordance with **8.1** shall be prepared appropriately as given in **8.3.1** and **8.3.2**.

8.3.1 *Forging Stock (Extruded or Rolled)*

a) Test samples from bars/sections not greater than 40 mm diameter or minor sectional dimension shall be cut from the material as supplied, heat-treated in the case of a heat-treatable alloy in full

cross section and one test specimen machined out co-axially to the largest size.

b) Test samples from bars/sections greater than 40 mm diameter or minor sectional dimension shall be forged hot to 40 mm or equivalent section and subsequently heat-treated in the case of a heat-treatable alloy and one test specimen machined out co-axially to the largest size.

NOTE — In either case, prepared test samples shall not be annealed or mechanically worked (except for straightening and machining the test piece) before being tested.

8.3.2 *Forging Stock (Cast)* — For cast material, the preparation of the test samples shall be agreed to between the supplier and the purchaser.

8.4 Preparation of Test Samples for Forgings — Unless otherwise agreed, test samples to represent each batch of forgings shall be prepared appropriately as given in **8.4.1** to **8.4.5**.

8.4.1 For forging made from wrought stock not greater than 40 mm diameter or minor sectional dimension, test samples shall be cut from the unforged stock for testing in the same condition as the forgings are to be supplied or wherever practicable may be cut from the actual forging after heat treatment in the case of an heat-treatable alloy

8.4.2 For forgings made from wrought stock of over 40 mm diameter or minor sectional dimension, test samples shall be cut from the forging stock and hot-forged to 40 mm diameter or equivalent section for testing in the same condition as the forgings are to be supplied or wherever practicable to be cut from the actual forging after heat treatment in the case of an heat-treatable alloy.

8.4.3 For forgings made from cast stock, test samples shall be cut from actual forgings, after heat treatment in the case of an heat-treatable alloy. Alternatively they may be adequately forged hot from stock of the same specification.

NOTE — Test samples from forgings shall be taken in the longitudinal direction.

8.4.4 All test samples shall be heat-treated, if heat treatment is required similar to and simultaneously with the forgings they represent and shall not be further heat-treated, forged or mechanically worked except by machining to shape before they are tested.

8.4.5 Test samples shall be marked to identify them with the forgings they represent.

9. MECHANICAL TEST

9.0 The following tests shall be made on test pieces prepared from test samples selected as specified under **8**.

9.1 Tensile Test — The tensile test shall be carried out and the proof stress determined thereby in accordance with IS : 1816-1961*.

9.1.1 When test samples are 50 mm or less of diameter or minor sectional dimensions, the test pieces shall be machined co-axially from the test sample, when the test samples are over 50 mm and up to 200 mm diameter or minor sectional dimension, the longitudinal axis of the test pieces shall be not less than 25 mm from the surface of the test sample.

10. RETESTS

10.1 Should any one of the test pieces first selected fail to pass the mechanical tests, two further samples from the same lot shall be selected for testing, one of which shall be from the forging stock or forgings from which the original test sample was taken unless that forging stock or forgings has been withdrawn by the supplier.

10.2 Should the test pieces from both these additional samples pass, the lot represented by the test samples shall be deemed to comply with the requirements for mechanical properties. Should the test pieces from either of these additional samples fail, the lot represented by the test samples shall be rejected.

10.3 For heat-treatable alloys the supplier shall have the right if he so desires, to reheat the material before the two further samples are selected.

11. MARKING

11.1 Forging stock and forgings may be suitably marked for identification, with the name of the manufacturer, designation and condition of the material. The supplier shall furnish a certificate that the material supplied complies with the requirements of this standard.

11.1.1 The material may also be marked with the ISI Certification Mark. The supplier's certification (*see* **11.1**) shall be implied if the material is certified under the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

*Method for tensile testing of light metals and their alloys.

TABLE 1 CHEMICAL COMPOSITION OF WROUGHT ALUMINIUM AND ALUMINIUM ALLOY FORGING STOCK AND FORGINGS (FOR GENERAL ENGINEERING PURPOSES)

(*Clause* 5.1)

(Composition limits are in percent maximum unless shown otherwise.)

Designation		Aluminium	Copper	Magnesium	Silicon	Iron	Manganese	Zinc	Titanium and/or Other Grain Refining Elements	Chromium	Remarks
New	Old										
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
19000	FIC	99·0 *Min*	0·1	0·2	0·5	0·7	0·1	0·1	—	—	Cu+Mg+Si+Fe+Mn+Zn=1·0
19500	FIB	99·5 *Min*	0·05	—	0·3	0·4	0·05	0·1	—	—	Cu+Si+Fe+Mn+Zn=0·5
22588	HF18	Remainder	**1·8-2·7**	**1·2-1·6**	1·3	**0·6-1·2**	0·2	0·2	0·3	—	Ni=0·6 to 1·4
24345	HF15	Remainder	**3·8-5·0**	**0·2-0·8**	**0·5-1·2**	0·7	**0·3-1·2**	0·2	*0·3	*0·3	
24534	HF14	Remainder	**3·5-4·7**	**0·4-1·2**	**0·2-0·7**	0·7	**0·4-1·0**	0·2	0·3	—	
31000	NF3	Remainder	0·1	0·1	0·6	0·7	**0·8-1·5**	0·2	0·2	0·2	
52000	NF4	Remainder	0·1	**1·7-2·6**	0·6	0·5	0·5	0·2	0·2	0·25	Cr+Mn=0·5
53000	NF5	Remainder	0·1	**2·8-4·0**	0·6	0·5	0·5	0·2	0·2	0·25	Cr+Mn=0·5
54300	NF8	Remainder	0·1	**4·0-4·9**	0·4	0·5	**0·5-1·0**	0·2	0·2	0·25	
63400	HF9	Remainder	0·1	**0·4-0·9**	**0·3-0·7**	0·6	0·3	0·2	0·2	0·1	
64423	—	Remainder	**0·5-1·0**	**0·5-1·3**	**0·7-1·3**	0·8	1·0	—	—	—	
64430	HF30	Remainder	0·1	**0·4-1·2**	**0·6-1·3**	0·6	**0·4-1·0**	0·1	0·2	0·25	
65032	HF20	Remainder	**0·15-0·4**	**0·7-1·2**	**0·4-0·8**	0·7	**0·2-0·8**	0·2	0·2	**0·15-0·35**	Either Mn or Cr shall be present
74530		Remainder	0·2	**1·0-1·5**	0·4	0·7	**0·2-0·7**	**4·0-5·0**	0·2	0·2	

NOTE — It is the responsibility of the supplier to ensure that any element not specifically limited is not present in an amount such as is generally accepted as having an adverse effect on the product. If a purchaser's requirements necessitate limits for any element not specified these should be agreed to between the supplier and the purchaser.

*Titanium and/or other grain refining elements and/or chromium may be present at the option of the supplier provided the total content does not exceed 0·3 percent.

TABLE 2 MECHANICAL PROPERTIES OF WROUGHT ALUMINIUM AND ALUMINIUM ALLOY FORGING STOCK AND FORGINGS (FOR GENERAL ENGINEERING PURPOSES)

(*Clause* 5·1)

Designation		Condition	Condition of Test Sample	Size of Bar		0·2 Percent Proof Stress *Min*	Tensile Strength *Min*	Elongation on 50 mm Gauge Length *Min*
New	Old			Over	Up to and Including			
(1)	(2)	(3)	(4)	(5) mm	(6) mm	(7) N/mm² (kgf/mm²)	(8) N/mm² (kgf/mm²)	(9) Percent
19000	FIC	*M/O	Forged or Extruded	—	—	—	65(6·5)	18
19500	FIB	*M/O	Forged or Extruded	—	—	—	65(6·5)	23
22588	HF18	WP	a) Forged	—	—	265(27·0)	375(38·0)	—
			b) Extruded	—	—	265(27·0)	385(39·5)	—
24345	HF15	W	a) Forged	—	—	225(23·0)	375(38·0)	—
			b) Extruded	—	10	225(23·0)	375(38·0)	10
				10	75	235(24·0)	385(39·5)	10
				75	150	235(24·0)	385(39·5)	—
				150	200	225(23·0)	375(38·0)	—
		WP	a) Forged	—	—	385(39·5)	445(45·5)	6
			b) Extruded	—	10	375(38·0)	430(44·0)	6
				10	25	400(41·0)	460(47·0)	6
				25	75	420(43·0)	480(49·0)	—
				75	150	405(41·5)	460(47·0)	—
				150	200	380(38·5)	430(44·0)	—

24534	HF14	W		—	10	220(22·5)	375(38·0)	10
				10	75	235(24·0)	385(39·5)	10
				75	150	235(24·0)	385(39·5)	8
				150	200	225(23·0)	375(38·0)	8
31000	NF3	*M/O	Forged or Extruded	—	—	—	105(10·5)	—
52000	NF4	*M/O	Forged or Extruded	—	—	—	170(17·5)	14
53000	NF5	*M/O	a) Forged	—	—	—	215(22·0)	14
			b) Extruded	—	50	—	215(22·0)	14
				50	—	—	200(20·5)	14
54300	NF8	O	Forged	—	—	—	265(27·0)	13
		*M	Extruded	—	—	—	275(28·0)	11
63400	HF9	W	a) Forged	—	—	80(8·0)	140(14·0)	14
			b) Extruded	—	150	80(8·0)	140(14·0)	14
				150	200	80(8·0)	125(12·5)	—
		WP	a) Forged	—	—	150(15·5)	185(19·0)	7
			b) Extruded	—	150	150(15·5)	185(19·0)	7
				150	200	130(13·0)	150(15·5)	—
64423	—	W	a) Forged	—	—	155(16·0)	265(27·0)	14
			b) Extruded	—	—	155(16·0)	265(27·0)	14
		WP	a) Forged	—	—	265(27·0)	330(33·5)	9
			b) Extruded	—	—	265(27·0)	330(33·5)	9
64430	HF30	W	a) Forged	—	—	120(12·0)	185(19·0)	14
			b) Extruded	—	150	120(12·0)	185(19·0)	14
				150	200	100(10·0)	170(17·5)	—
		WP	a) Forged	—	—	255(26·0)	295(30·0)	7
			b) Extruded	—	5	255(26·0)	295(30·0)	7
				5	75	270(27·5)	310(31·5)	7
				75	150	255(26·0)	295(30·0)	—
				150	200	240(24·5)	280(28·5)	—

(*Continued*)

TABLE 2 MECHANICAL PROPERTIES OF WROUGHT ALUMINIUM AND ALUMINIUM ALLOY FORGING STOCK AND FORGINGS (FOR GENERAL ENGINEERING PURPOSES) — *Contd*

Designation		Condition	Condition of Test Sample	Size of Bar		0·2 Percent Proof Stress *Min*	Tensile Strength *Min*	Elongation on 50 mm Gauge Length *Min*
New	Old			Over	Up to and Including			
(1)	(2)	(3)	(4)	(5) mm	(6) mm	(7) N/mm² (kgf/mm²)	(8) N/mm² (kgf/mm²)	(9) Percent
65032	HF20	W	a) Forged	—	—	115(11·5)	185(19·0)	14
			b) Extruded	—	150	115(11·5)	185(19·0)	14
				150	200	100(10·0)	170(17·5)	14
		WP	a) Forged	—	—	235(24·0)	280(28·5)	7
			b) Extruded	—	150	235(24·0)	280(28·5)	7
				150	200	195(20·0)	245(25·0)	7
74530	—	W (naturally aged for 30 days)	a) Forged	—	—	220(22·5)	255(26·0)	9
			b) Extruded	—	6·3	220(22·5)	255(26·0)	9
				6·3	75·0	230(23·5)	275(28·0)	9
				75·0	150·0	220(22·5)	260(26·5)	9
		WP	a) Forged	—	—	245(25·0)	285(29·0)	7
			b) Extruded	—	6·3	245(25·0)	285(29·0)	7
				6·3	75·0	260(26·5)	310(31·5)	7
				75·0	150·0	245(25·0)	290(29·5)	7

NOTE 1 — For cast forging stock, the properties shall be agreed to between the supplier and the purchaser.

NOTE 2 — N/mm² (Newton per square millimetre) = 0·102 kgf/mm².

*Properties in M temper are only typical values and given for information only.

APPENDIX A

(*Clause* 0.3)

CHARACTERISTICS AND TYPICAL USES OF ALUMINIUM ALLOYS

Designation		Characteristics	Available Forms	Typical Uses
New	Old			
19000	FIC	Commercially pure aluminium. Very ductile in annealed or extruded condition. Excellent resistance to corrosion.	Sheet, plate, extrusion, tube, wire and forgings.	Panelling and moulding, refrigeration tubing equipment for chemical, food and brewing industries; packaging; cooking utensils. Sheet metal work, architectural and builder's hardware, spun/pressed hollow ware, deep drawn parts, cladding, welding wire and electrical appliances.
19500	FIB	High purity aluminium more resistant to corrosion than other alloys.	Sheet, plate, extrusion, tube, wire, rolled rod and forgings.	Corrosion resistant cladding on stronger alloys; impact extruded containers; food, chemical, brewing and processing equipment; tanks and pipes; marine fittings; reflectors; pressed and anodized utility items, jewellery, and cable sheathing.
22588	HF18	Has good combination of mechanical and physical characteristics including low thermal expansion, has longer fatigue life.	Forging.	Suitable for forging aircraft/automobile pistons, cylinder heads, aircraft undercarriage wheels, etc.
24345	HF15	Combines high strength with fair ductility in the solution treated condition, when forming can be done and parts subsequently aged.	Sheet, plate, extrusion, tube, wire and forgings.	Heavy duty forgings, structures where high mechanical properties are of utmost importance, aircraft application of clad sheets, extrusions, armaments, etc.

Designation		Characteristics	Available Forms	Typical Uses
New	Old			
24534	HF14	Strong alloy that is aged naturally at room temperature after solution treatment and has fair ductility in this condition.	Extrusion, tube, wire, rolled rod and forgings.	Stressed parts in aircrafts and other structures where high strength is of primary consideration.
31000	NF3	Stronger and harder than 19000 but has good workability, weldability and corrosion resistance.	Sheet, plate, extrusion, wire, tube, rolled rod and forgings.	General-purpose alloy for moderate strength applications, pressure vessels, irrigation tubing, heat exchangers, utensils and pressure cookers, roofing sheets, pilfer proof caps, detonator caps, air-conditioning ducting fan blades and vehicle panelling.
52000	NF4	Ductile in the soft condition, but work-hardens rapidly, becoming extremely tough. Has high resistance to corrosive attack especially in marine atmosphere.	Sheet, plate, extrusion, tube, wire and forgings.	Panelling and structures, sheet metal work and domestic appliances, marine applications like sheathing/lining of boat bottom, etc.
53000	NF5	do	Sheet, plate, extrusion, tube, wire and rolled rod.	Shipbuilding, rivets, pressure vessels and other processing tanks, cryogenics, and welded structures.
54300	NF8	do	Sheet, plate, extrusion and forgings.	Welded structures, cryogenic applications, structural marine applications, rail and road tank cars, rivets and missile components.
63400	HF9	Suitable for intricate extruded sections of medium strength. Forms well in W condition. Highly corrosion resistant.	Extrusion, tube, wire, rolled rod and forgings.	Architectural uses, such as window/door-frames, wall facings, partitions, hand rails, etc, and other similar applications where surface finish is important and medium strength would suffice.

64423	—	Stronger than 64430 and has superior machinability.	Extrusions.	Applications requiring good strength and machinability such as textile machinery components.
64430	HF30	Medium-strength alloy with good mechanical properties, corrosion resistance and weldability.	Sheet, plate, extrusion, tube, wire and forgings.	Structural applications of all kinds, such as road and rail transport vehicles, bridges, cranes, roof trusses, rivets, etc. Cargo containers, milk containers, deep-drawn containers, and flooring.
65032	HF20	Medium-strength alloy similar to 64430.	Sheet, plate, extrusion, tube, wire and forging.	Similar to 64430
74530	—	Medium-strength self-ageing weldable alloy. It does not require heat treatment after hot working or welding. Excellent welding characteristics and good formability. Good corrosion resistance when compared with other high strength aluminium zinc alloys.	Sheet, plate, extrusion and forgings.	Stressed structural applications requiring welding, such as bridges, chequered plates, dump-truck bodies, pressure vessels, rail coaches, etc.

(*Continued from page* 2)

Wrought Aluminium and Its Alloys Subcommittee, SMDC 10 : 3

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